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“Interoperability Among Future Miniature Munition/Stores and
Dispensing Systems”

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14. ABSTRACT A new generation of smart air launched miniature munitions/stores including such stores as the Small Diameter Bomb (SDB) is in the early stages of development by the services. The initial versions of these stores will range primarily from 100 to 350 pounds, with variants for attack of fixed, re-locatable, and mobile targets. The primary carriage mode for existing aircraft will be via advanced captive dispensers with internal electronics, which provide for interfacing and carriage of multiple miniature stores on a single aircraft store station. Some future aircraft or unmanned combat air vehicles may, however, provide areas for direct primary carriage and interfacing of these stores without intervening carriage devices. To minimize the logistics impact, the dispensing system will be common in design and/or technology and have application across multiple munition types and delivery platforms.					
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1.0 INTRODUCTION/BACKGROUND

A new generation of smart air launched miniature munitions/stores including such stores as the Small Diameter Bomb (SDB) is in the early stages of development by the services. The initial versions of these stores will range primarily from 100 to 350 pounds, with variants for attack of fixed, re-locatable, and mobile targets. The primary carriage mode for existing aircraft will be via advanced captive dispensers with internal electronics, which provide for interfacing and carriage of multiple miniature stores on a single aircraft store station. Some future aircraft or unmanned combat air vehicles may, however, provide areas for direct primary carriage and interfacing of these stores without intervening carriage devices. To minimize the logistics impact, the dispensing system will be common in design and/or technology and have application across multiple munition types and delivery platforms.

The planned miniature stores will require initialization and release sequencing services from the host carriage platform prior to release to effectively perform their mission. Consequently, an electrical/ functional interface must be provided between the dispenser and the miniature stores. To prevent widespread proliferation of unique electrical interfaces and promote interoperability across programs, services, and allied nations, it is essential that this interface be standardized. Due to unique factors relative to this class of stores including severe space restrictions, stringent cost constraints, and the need for very low or non-existent release separation forces, direct application of the existing MIL-STD-1760 aircraft/store electrical interface standard in its present form is not considered practical. MIL-STD-1760 interfaces will be available for interfacing from the aircraft to the dispenser on most planned near term carriage platforms, though.

To address the need for a common dispenser/miniature store electrical interface with the desired attributes, a Miniature Munition/Store Interface Task Group (MM/SITG) was formed within the Society of Automotive Engineers (SAE) Avionics System Division several years ago to support joint industry/government definition and coordination of a standard for such an interface. The remainder of this paper describes the interface requirements analysis and interface definition efforts conducted to date, and summarizes the current status and future plans for interface coordination and application.

2.0 INTERFACE REQUIREMENTS

The first step toward definition of the interface consisted of a fairly extensive requirements definition and coordination effort. Initial requirements were developed through interviews with government and industry technologists involved in relevant programs. These initial requirements were further expanded and refined through coordination within the SAE MM/SITG, which includes a broad representation of U.S. and international weapon and aircraft developers. The documented requirements are subsequently discussed in terms of carriage configurations and the associated interface hierarchy which was defined, and the required interface services which were identified for the subject class of stores.

2.1 Carriage Configurations and Interface Hierarchy

To aid in developing an interface nomenclature and in understanding the related system physical relationships, baseline interface carriage configurations were initially documented. Two major

variants were postulated based on prevailing implementation concepts. The first was the basic dispenser configuration (illustrated in Figure 1) where multiple miniature stores are carried on a dispenser that attaches to a single aircraft store station with a MIL-STD-1760 Aircraft Station Interface (ASI). Electronics within the dispenser provide a remote terminal interface to the aircraft stores bus and serve as a bridge to the multiple miniature store interfaces at the respective dispenser stations. Growth provisions for up to 256 store stations on a single dispensing device were identified as a goal to support long term applications, though most envisioned near term applications will involve from four up to eighteen or twenty miniature stores on a single dispenser.

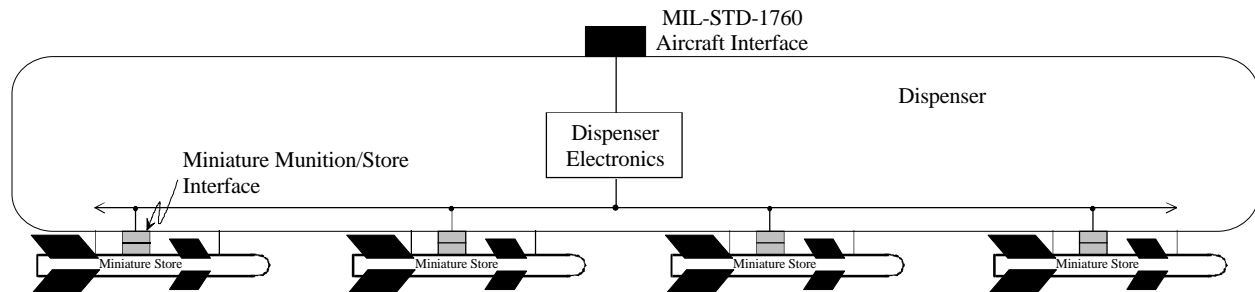


Figure 1. Basic Dispenser Carriage Configuration

The second major identified carriage configuration consists of subpacks containing two stores which are carried at a single dispenser station, and released as a unit. The stores separate from the subpack some time after release of the overall package from the dispenser. It was decided that from an electrical standpoint, each store would in this instance interface independently to the dispenser through a separate dispenser/miniature store interface. It was also decided if the subpack contained any additional electronics (independent of the stores) requiring aircraft/dispenser interface services, that a third independent interface would be used. The subpack carriage arrangement and associated interfacing scheme is illustrated in Figure 2.

From the baseline interface configurations, an interface hierarchy of the dispenser/miniature store and related MIL-STD-1760 interfaces was developed to provide a framework for interface definition. This hierarchy is illustrated in Figure 3. As illustrated, the dispenser interfaces to the aircraft through an umbilical cable between a MIL-STD-1760 Mission Store Interface (MSI) on the dispenser and Aircraft Station Interface (ASI) on the aircraft. The ASI and MSI are defined in detail in MIL-STD-1760 and are not being directly addressed as part of the miniature store interface definition effort. Interfacing to the miniature stores on the other side of the dispenser is via mating interface halves designated as Dispenser Station Interfaces (DSIs) and Miniature Mission Store Interfaces (MMSIs). This mating arrangement does not presume an umbilical cable, since blind mating and other physical interconnection approaches may also be used in some applications. Connectorless interface technologies are also considered a possibility for next generation versions of the interface.

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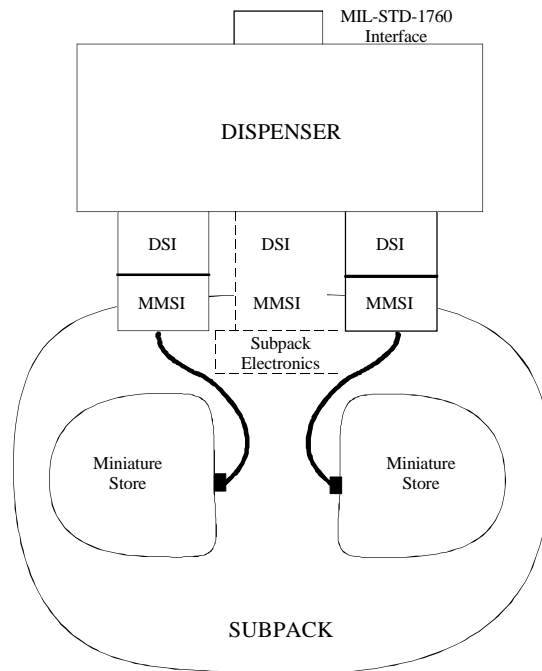
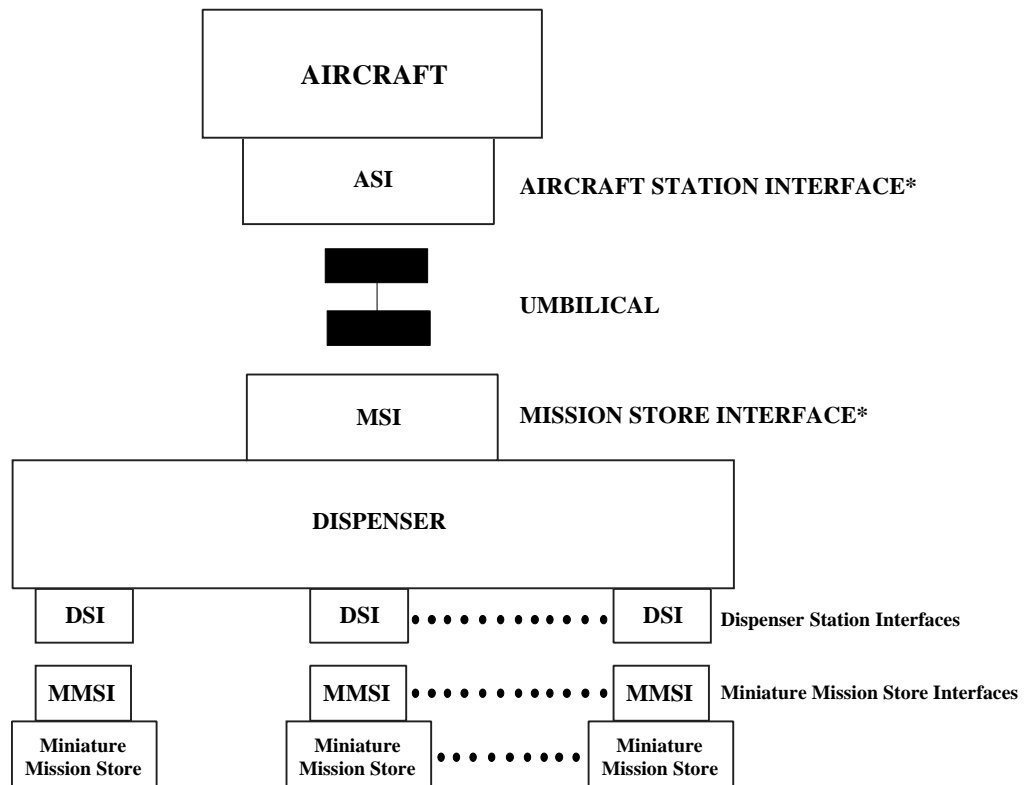


Figure 2. Subpack Carriage Configuration



* MIL-STD-1760 Interfaces

Figure 3. Interface Hierarchy

2.2 Required Interface Services

After definition of basic carriage configurations and the associated interface hierarchy/nomenclature, focus was turned toward the actual interface services required to support miniature store initialization and release processes. Requirements for interface power, signal, and interconnection provisions were consequently documented and are summarized in terms of the identified major required interface elements as follows:

- a. Power Interface – The capability to transfer both steady state operating power and safety enabled transient power is required. This consists of a requirement for the transfer of up to 175 watts operating power from the dispenser to the store on a continuous basis, and a requirement for the transfer of transient power of 100 watts maximum for up to 100 milliseconds from the dispenser to the store for performing safety critical functions (squib firing, etc.). Power activation at all individual dispenser stations must be independently controllable. A safety return path for interface power is also required.
- b. Digital Data Interface – A bidirectional digital data interface is required for confirmed (as applicable) communication of command and control, initialization, targeting (including imagery), and status data between dispensers and stores. The dispenser functions as the controller of all communications, with the stores responding as remote terminals or slave devices. A minimum data throughput of 4 megabits per second including factors for protocol overhead and growth must be supported, with provisions for both aperiodic (event driven) and periodic data transfers. Ground re-programming and built-in-test (BIT) of stores must also be accommodated by this interface. Flexibility for growth in this interface to accommodate future requirements is also desired.
- c. Address/Routing Interface – The capability for a location dependent assignment of a unique address to each store attached to a dispenser is required to support communications associated with the Digital Data Interface. The addressing scheme must accommodate up to 256 store stations per dispenser.
- d. Discrete Function Interface – A capability is required for high integrity transfer of certain safety related discrete state conditions across the interface. This includes a safety enable (or release consent) indication from the dispenser to the store which is used as consent to the store to perform certain critical and/or irreversible functions (battery squib activation, arm enable, etc.) associated with the release sequence. The capability to indicate interface mated status via the interface to both the dispenser and store is also required.
- e. High Bandwidth Interface – The interface is required to provide high bandwidth signal transfer capabilities for transferring raw GPS radio frequency (RF) signals and the GPS Time Mark Pulse or 1 PPS Pulse from the dispenser to attached stores. Concurrent transfer of both the GPS RF and timing pulse signals is not required. Consideration is also to be given to capabilities (possibly growth features) for transferring analog or digital video signals from the store to the dispenser for pre-launch seeker checkout, etc., and for a high speed digital data transfer capability for reduced time transfer of large data blocks.

f. Physical Interconnection Interface – A physical interconnection mechanism for mating the dispenser/store signal paths across the point of interface connection/disconnection is required. Size (volume and area footprint) is to be minimized to the extent feasible. The defined physical interconnection mechanism must also be compatible with multiple mating/de-mating cycles, and have a storage life of 20 years minimum. A blind mate push-on type connector arrangement is designated as the primary requirement for the physical interconnection implementation, with an additional requirement for a self-retaining feature to support other physical (non-blind mate) configurations. The DSI side of the physical interface must also provide for retention of an in-flight protective cover for unused stations. The physical interface must additionally have minimal or no impact on store separation characteristics. It is further required to be compatible with carrying platform EMI/physical/environmental parameters, for both internal bay carriage and external carriage configurations.

3.0 INTERFACE DEFINITION

After agreement within the MM/SUTG on miniature store interface requirements as described above, definition of an interface to satisfy these requirements and serve as the basis for the planned standard was undertaken. Though the detailed definition is still in progress, core elements of the definition have been agreed to. The evolving interface definition is consequently described here in terms of the interface signal set and the physical interconnection interface.

3.1 Interface Signal Set

A signal set to provide the required interface signal transfer services was defined and coordinated, and is illustrated in Figure 4.

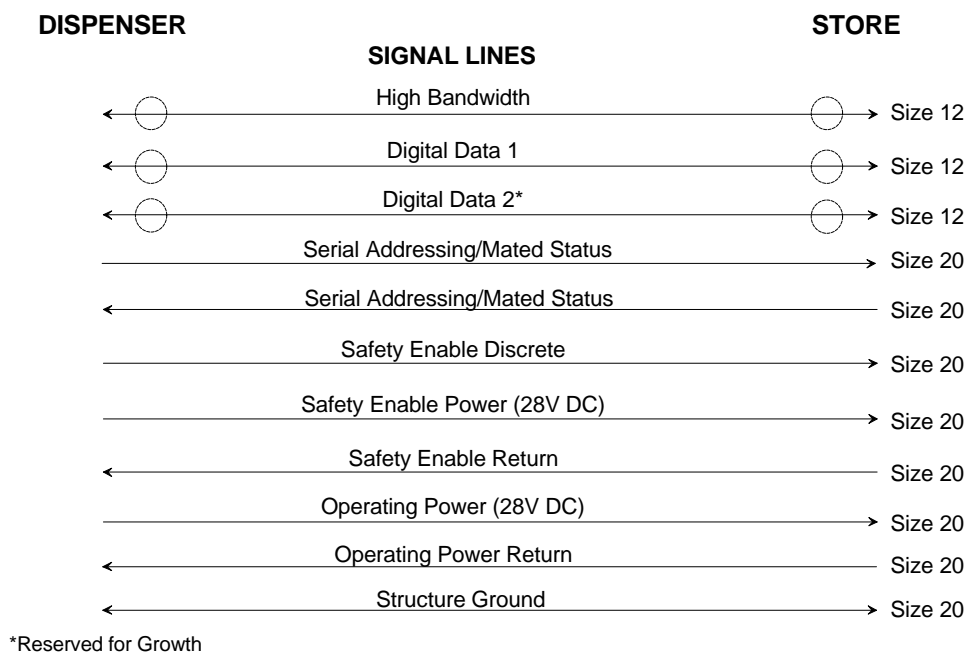


Figure 4. Miniature Munition/Store Interface (MMSI) Signal Set

The illustrated signal set contains three size 12 multi-conductor contacts for high bandwidth and data signal transfer (including growth provisions), and eight size 20 conventional single conductor contacts for transfer of the remaining signals. The specific signal interfaces and associated paths included to support the previously identified interface functional requirements are summarized at a top level as follows:

High Bandwidth Interface – A single high quality (i.e., impedance controlled) 50 ohm coaxial contact supports non-concurrent transfer of Type A (20 Hz to 20 MHz) or Type B (20 MHz to 1.6 GHz) high bandwidth signals of the type defined in MIL-STD-1760. This is consistent with GPS timing pulse or RF signal transfer requirements.

Digital Data Interface – The digital data interface consists of a shielded contact which supports bidirectional data transfers. The specified protocol is tentatively based on MIL-STD-1553 requirements with the bit rate modified to 10 megabits per second (versus 1 megabit per second) and timing parameters scaled accordingly. The dispenser functions as a MIL-STD-1553 Bus Controller and the stores function as MIL-STD-1553 Remote Terminals. The MIL-STD-1553 electrical signal characteristics are additionally modified for compatibility with an EIA/TIA-485 based differential three state signaling scheme. The interconnection network approach is based on a logical bus architecture with an active hub at the dispenser electronics and point-to-point paths to each DSI on the dispenser. This approach is illustrated in Figure 5. Additional details of the Digital Data Interface are still being defined.

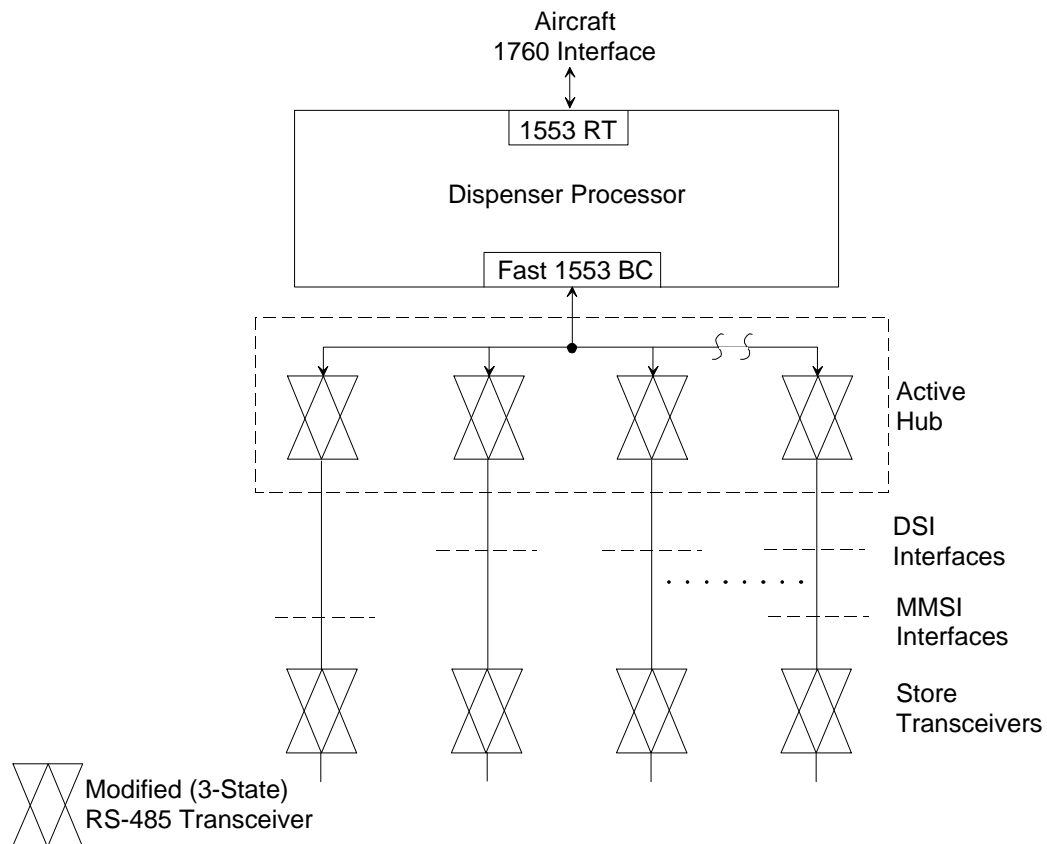


Figure 5. Digital Data Interface Physical Network Architecture

Serial Addressing/Mated Status Interface – The Serial Addressing Interface which also serves a dual purpose for determining interface mated status consists of a contact pair for transferring serially encoded address information from the dispenser electronics to the store. The transferred address is used as the store remote terminal address for primary communications via the Digital Data Interface. Controller Automation Network (CAN) protocol has been selected as the means of address information transfer over this interface, and detailed operation is currently being defined. CAN is a commercial standard with a wide range of low cost support electronics readily available. The CAN message traffic will also be used to determine interface mated status on the two sides of the interface.

Safety Enable Discrete Interface – This is a 28 V nominal discrete signal referenced to Safety Enable Power Return which is used as authorization for the store to perform certain critical functions in response to messages over the Digital Data Interface. Its characteristics are analogous to those for the MIL-STD-1760 Release Consent signal.

Safety Enable Power Interface – The Safety Enable Power Interface (including return) provides a short term source of power of up to 5 amperes at a nominal voltage of 28V DC to the store. It is only enabled when it is okay for the store to perform critical irreversible functions associated with the release sequence.

Operational Power Interface – The Operational Power Interface (with return) provides a continuous source of nominal 28V DC power at a power level of 175 watts maximum to the store for non-critical initialization and release sequence functions.

Structure Ground Interface – The Structure Ground Interface is a continuity path between the structures on the two sides of the interface to prevent excessive potential differences (for personnel safety) and provide a fault return path for the interface power sources.

3.2 Physical Interconnection Interface

In addition to the signal set definition, work is underway to define a physical interconnection approach compatible with the dispenser/miniature store interface requirements. The currently evolving approach is based on a MIL-C-38999 type of connector using a shell size 17. A baseline insert arrangement for this approach is illustrated in Figure 6.

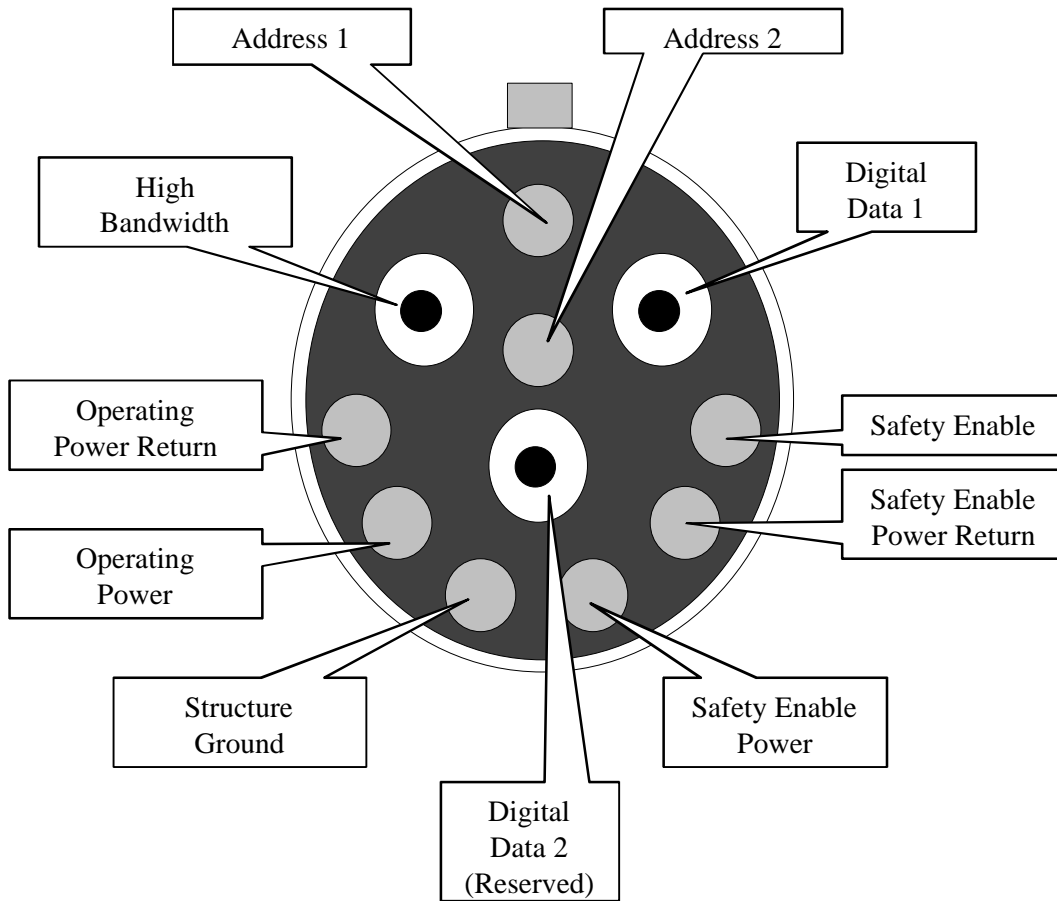


Figure 6. Baseline Connector Insert Arrangement

The present concept is to accommodate both blind mate and umbilical cable interconnection arrangements. In the case of umbilical mating, the upper end umbilical connector will mate with and be retained by the dispenser station connector. A separable (lanyard release, tear-away, etc.) connector which may be of a different type yet which still accommodates the required signals will connect the other end of the umbilical cable to the store. A notional miniature store interface connector family supporting these options as well as associated test functions is illustrated in Figure 7.

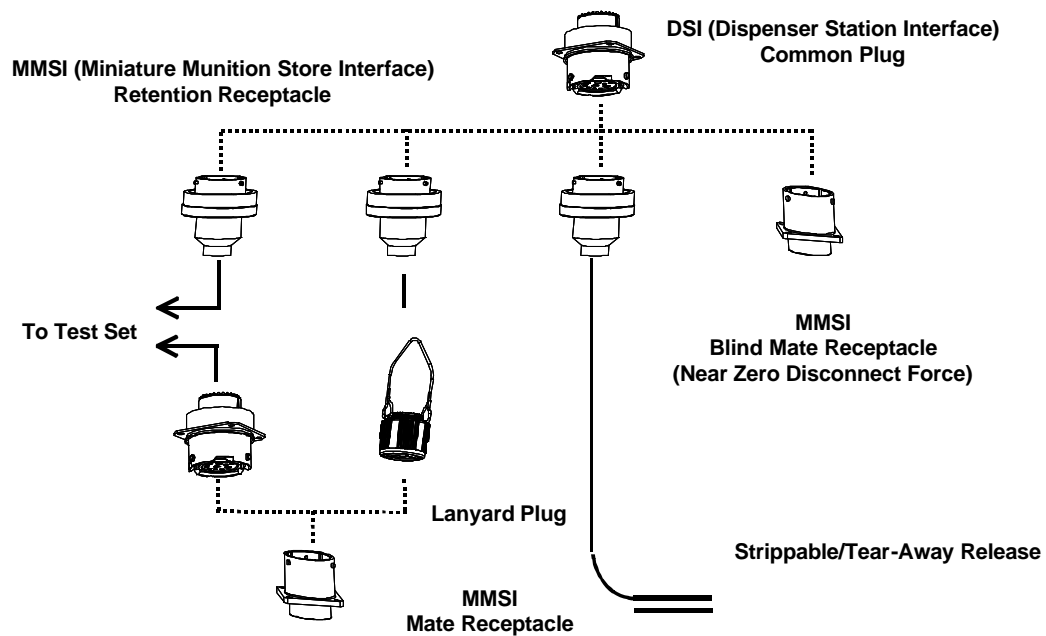


Figure 7. Notional Miniature Store Interface Connector Family

4.0 FUTURE PLANS

Work on the MMSI standard is ongoing within the SAE MM/SITG. Plans are to complete the remaining sections of the draft standard and coordinate/refine it within the task group. After group approval, it will be submitted to the government as a recommended military standard. It will then undergo government coordination and approval before publication as a military standard. The intent is that it will then serve as the basis for the interface between all future miniature munitions/stores and their carrying platforms, to ensure true interoperability across weapon programs, military services, and allied nations.